(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
15 March 2001 (15.03.2001)

PCT

(10) International Publication Number
WO 01/18506 A1

(51) International Patent Classification[7]: G01G 19/414

(21) International Application Number: PCT/US00/23681

(22) International Filing Date: 29 August 2000 (29.08.2000)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/152,420 3 September 1999 (03.09.1999) US
60/152,425 3 September 1999 (03.09.1999) US

(71) Applicant: SIEMENS AUTOMOTIVE CORPORATION [US/US]; 2400 Executive Hills Drive, Auburn Hills, MI 48326 (US).

(72) Inventors: REICH, Daniel; 54196 Bartran Drive, Macomb, MI 48042 (US). QUAIL, Alanna, Marie; 4082 Calument Drive, Oakland Twp., MI 48306 (US). GARCIA, Emmanuel, V.; 3064 Glouchester Drive, Sterling Heights, MI 48310 (US).

(74) Agents: SLENZAK, Laura, M.; c/o Keller, Elsa, Siemens Corporation, 186 Wood Avenue South, Iselin, NJ 08330 et al. (US).

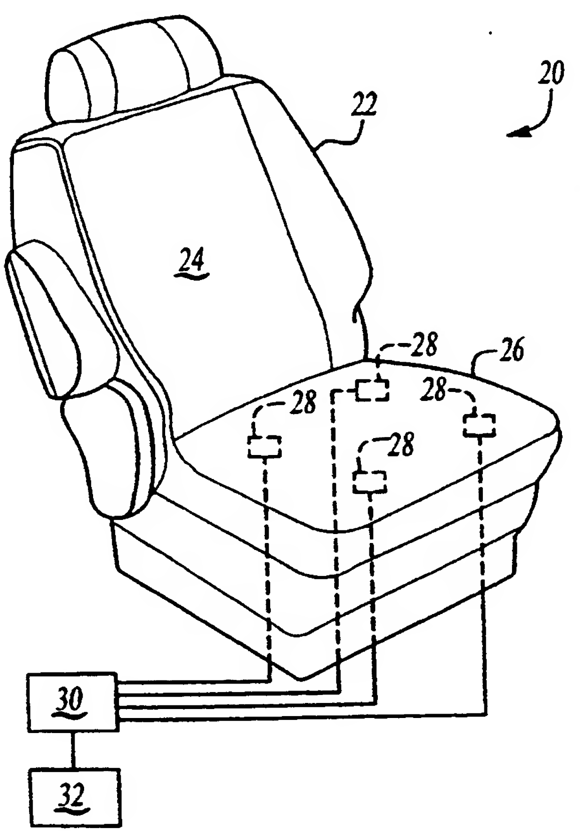
(81) Designated States *(national)*: CN, KR.

(84) Designated States *(regional)*: European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

Published:
— *With international search report.*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: METHOD OF CLASSIFYING WEIGHT INFORMATION IN A VEHICLE WEIGHT CLASSIFICATION SYSTEM



(57) Abstract: A vehicle weight classification system (20) includes a method of classifying weight information. A plurality of zones (52, 54, 56, 58, 60) are defined and are associated with each of the weight classifications (44, 46, 48, 50). In one example, the upper and lower limits of the zones overlap those of an adjacent zone. The upper and lower limits of the zones preferably also overlap the thresholds of the corresponding weight classifications. Whenever weight information exists within a zone, a value for that zone is increased. The zone having the highest value is determined to be the zone where the weight information should be classified. The weight information is then classified into the classification associated with the zone having the highest value.

WO 01/18506 A1

METHOD OF CLASSIFYING WEIGHT INFORMATION IN A VEHICLE WEIGHT CLASSIFICATION SYSTEM

BACKGROUND OF THE INVENTION

This invention generally relates to vehicle weight classification systems. More particularly, this invention relates to a method of classifying weight information in a vehicle weight classification system.

Modern day vehicles include several types of safety restraint devices. Conventional seat belts are provided to secure drivers and passengers in a safe position on their seat. Additionally, airbags have been included in vehicles as an additional safety restraint device to prevent injury during an accident. While airbags have proven useful, they are not without drawbacks. One issue that has been recognized in the industry is that it would be advantageous to customize the deployment of an airbag based upon a seat occupant's size or weight.

Current systems for measuring the weight of a seat occupant are complex and expensive. Sensors are placed at a plurality of locations in the seat bottom and the combined output from the sensors is used to determine the weight of the seat occupant. Each sensor experiences a substantially vertical force, due to the weight of the seat occupant, but is also subject to longitudinal and lateral forces caused by acceleration, deceleration, turning, or adverse road conditions. The lateral and longitudinal forces picked up by the sensor incorporate an error component into the weight measurement. These sensors often cannot correct error due to changes in occupant seating position or adverse road conditions.

Information from the weight classification system preferably is used to control the operation of the airbag in the event of an accident. Some systems attempt to classify seat occupants into predetermined customer-specified classes usually based only on occupant weight. The classification information is then used to modify the deployment of the airbag. These systems do not provide accurate and consistent classification over a wide range of adverse road conditions and/or occupant seating conditions.

Those skilled in the art are constantly striving to make improvements to vehicle safety systems. This invention presents a more robust decision strategy for classifying weight information that is then used to control airbag deployment. A system designed according to this invention makes more intelligent decisions regarding weight classification compared to prior techniques.

SUMMARY OF THE INVENTION

In general terms, this invention is a method for classifying weight information in a vehicle weight classification system.

One aspect of the preferred method of this invention includes several steps. First, a plurality of classification zones are defined that correspond to vehicle manufacturer weight classifications. A determination is made when the weight information is within one of the zones. Whenever the weight information is within a zone, a value for that zone is increased. The weight information is classified into the classification associated with the zone that has the highest value.

In one example, the value of each zone is determined by monitoring a representation of the weight information within the zone over time. A summation of that representation is used to determine a value for the zone. Additionally, whenever the weight information is not in a zone, the value of that zone preferably is decreased by a predetermined factor.

In one disclosed embodiment of this invention, the method for classifying a seat occupant into a weight class includes the following steps. The seat occupant weight is measured resulting in an estimated weight. The estimated weight is compared to a series of weight classes with thresholds to determine a class sample. The previous steps are repeated until a predetermined number of class samples having the same value is achieved and the class sample becomes locked as the occupant weight class.

Additional steps include generating an occupant weight class signal corresponding to the locked occupant weight class, transmitting the occupant weight class signal to a control unit, and modifying deployment of an airbag based on the occupant weight class signal. The weight class is unlocked when a predetermined number inconsistent class samples is observed. When the class is unlocked, the process repeats.

Once the occupant has been classified into a weight class, that class becomes the known class for the next comparison. Preferably, each weight class is assigned an upper threshold and a lower threshold. At each iteration, the estimated weight is compared to the upper and lower thresholds for the last known weight class. The new class sample is designated the same as the last known weight class if the estimated weight is between the upper and lower thresholds for the last known weight class. The sample is set equal to a next higher weight class if the estimated weight is greater than the upper threshold for the last known weight class or the class sample is set equal to a next lower weight class if the estimated weight is less than the lower threshold for the last known weight class.

In one disclosed embodiment, the value of the upper threshold of the class sample is increased by a first predetermined amount and the value of the lower threshold of the class sample is decreased by a second predetermined amount after the class sample is locked. The upper and lower thresholds are returned to their initial values when the class sample becomes unlocked.

The subject invention uses varying weight class thresholds and class sample histories to produce a more stable, accurate and robust classification process that reduces errors caused by changes in occupant seating position and adverse road conditions. The more accurate classification system is used to generate control signals, which are used to modify airbag deployment.

The various features and advantages of this invention will become apparent to those skilled in the art from the following detailed description of the currently preferred embodiments. The drawings that accompany the detailed description can be briefly described as follows.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 schematically illustrates a weight classification system designed according to this invention.

Figure 2 graphically illustrates an implementation of the method of this invention.

Figure 3 is a flowchart diagram illustrating a preferred method of this invention.

Figure 4 is a more detailed flowchart diagram illustrating a preferred method of this invention.

Figure 5 is a graph showing the relationship between track and lock thresholds.

Figure 6 is a flowchart describing the method of determining a weight class sample.

Figure 7 is a flowchart describing the tracking and locking processes.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

A vehicle weight classification system 20 is used to determine the weight of a person or load on a vehicle seat 22. The seat back 24 and seat base 26 are conventional except for the inclusion of a plurality of sensors 28 in the seat base 26. The sensors 28 gather information regarding the weight of an occupant of the seat 22 and provides signals to a control module 30, which preferably determines an approximate weight of the individual in the seat 22. More details regarding a weight determination or weight classification system with which this invention preferably is used can be found in United States Patent Application No. ______________, filed on November 12, 1998, which is commonly owned with this application. The teachings of that specification are incorporated into this specification by reference.

A weight classification module 32 preferably communicates with the weight determining module 30 and processes the weight information in a manner according to this invention. Although individual modules 30 and 32 are illustrated for discussion purposes, those skilled in the art will appreciate that a single controller may perform both weight determination functions and weight classification functions as may be needed in a given situation. The weight classification module 32 preferably comprises a suitably programmed microprocessor that gathers determined weight information and places it within a classification defined by a vehicle manufacturer or supplier.

Figure 2 graphically illustrates an implementation of the methodology of this invention. A graph 40 of the estimated weight information over time is shown by the

curve 42. A set of weight classifications, which preferably are determined by a vehicle manufacturer or airbag supplier, are illustrated by the thresholds 44, 46, 48 and 50. If the determined weight is below the threshold 44, for example, it fits within a first weight classification. The weight classifications correspond to a mode of airbag control or deployment. This invention provides a more robust and more intelligent strategy for deciding which classification the weight information fits into rather than simply placing the weight information into a current classification depending on an instantaneous output of the sensors 28.

A plurality of classification zones are defined and associated with the predetermined weight classifications. For example, zone 52 is associated with the weight classification 44 while zone 56 is associated with a third weight classification having a lower threshold at 46 and an upper threshold at 48. The other zones 54, 58 and 60 each correspond to a weight classification.

In the preferred embodiment of this invention, the upper limit of each classification zone preferably extends beyond the upper threshold of the corresponding weight classification. Additionally, the lower limit of each zone preferably extends below the lowest threshold of that weight classification. Additionally, the upper limit of one zone preferably overlaps the lower limit of an adjacent zone. Overlapping zone limitations provides additional decision making capability within the weight classification system of this invention.

The proper weight classification preferably is determined by determining a value within each zone that corresponds to the amount of time that the weight information is within the zone. In the illustrated example, integrating the area underneath the curve 42 within each zone provides a value for each zone, respectively. The integrated information provides the value of that zone.

It is most preferred to utilize some information within two zones at the same time. For example, at 62 the curve 42 passes through the first zone 52 and the second zone 54. Therefore, the value of each of those two zones preferably is increased based upon the weight information at 62.

The weight classification preferably is determined as the classification associated with the zone that has the highest value. In the illustrated example, the

zone within which the greatest integration result is achieved is considered the zone and the associated classification for the weight information. By monitoring the weight information over time and gathering increasing value information, the system 20 is capable of making a more robust and more accurate determination of the weight classification. Instead of merely sampling the weight information at any given time and assigning the weight classification as that classification in which a particular sampled weight information exists, the use of zones and integrating the weight information within each zone provides a more accurate weight classification determination. For example, even though the weight information is at 64 at one point in time, the system 20 determines that the weight information should be classified within the first classification beneath the threshold 44 even though the weight information at that instant is within the second classification between the threshold 44 and 46.

Figure 3 includes a flowchart diagram 70 that summarizes the preferred method of this invention. The classification zones 52, 54, 56, 58 and 60 preferably are defined based upon the weight classifications that have been previously determined. As discussed above, the upper and lower limits of each zone preferably overlap the limits of the corresponding classifications and preferably overlap adjacent zone limits. The determination module 32 determines when the weight is within a particular zone. A value for that zone is increased whenever the weight information is in that zone. The zone having the highest value is determined and the weight information is classified based upon the zone with the highest value.

Figure 4 includes a flowchart 80 that illustrates, in more detail, the preferred method of this invention. At 82, the controller module 32 determines whether the estimated weight is within a given zone. If the weight is within a zone, then the steps at 84 are processed to increase the value of that zone up to a maximum value. A maximum value preferably is set for each zone so that if the weight information stays within a zone over a prolonged period of time, that zone value does not increase beyond a chosen maximum. For each zone that does not contain the weight information, the steps at 86 preferably are completed. When a zone does not include the weight information, the value for that zone preferably is decreased by a

predetermined forgetting factor. This accommodates situations where the weight moves from one zone into another zone and allows the second zone to become the classification within a shorter period of time than if the value for the first zone were not decreased. The value for each zone preferably is only decreased to a chosen minimum value to avoid having extremely low zone values that may later inhibit an accurate weight determination. At 88, a determination is made whether the current zone or classification of the weight information is less than the value of the zone in which the weight information currently exists. Whenever a new zone has a higher value than a currently selected zone, the switch is made at 90 to the new zone and the weight classification is changed accordingly.

Another aspect of this invention is determining the boundaries or definitions of the weight classifications. The weight measurements taken by the sensors 28 can vary as the seat occupant changes seating positions and can vary as the vehicle travels through various maneuvers and over different types of roads. In order to provide a consistent and accurate weight classification, the classification process must filter out these variations. The subject invention monitors the occupant's estimated weight and compares the estimated weight to a series of weight class thresholds to determine an individual classification sample. A history of these class samples is observed and recorded by the control unit 30 and/or the classification module 32. Once a predetermined number of consistent and consecutive samples are observed, the class sample is locked as the occupant's weight class. Over time, a plurality of comparisons are made between the estimated weight and the weight class thresholds.

Each weight class is assigned a predetermined upper threshold and a predetermined lower threshold. The number and values for the upper and lower thresholds can be varied. Each weight class sample is determined by comparing the occupant's estimated weight against the previous weight class sample's thresholds. If the estimated weight falls between the upper and lower thresholds for that previous class, the current class sample is set to that last sample. If the estimated weight does not fall between the upper and lower thresholds for that previous class, either the weight class above or the weight class below the previous weight class is set for the current weight class depending on which threshold is crossed. Preferably, only one

incremental weight class change is permitted for each iteration. Allowing a change of only one class per iteration helps to smooth the transition between the classes.

The upper and lower thresholds for each class varies depending on whether the process is in the track mode or the lock mode. If the system is locked onto a specific weight class, the separation between the upper and lower thresholds for that weight class is increased to provide more hysteresis. By increasing the hysteresis when locked, it is more difficult to change or unlock the weight class designation. This helps to filter out unintended weight class changes, i.e., error induced by adverse road conditions or changes in occupant seating position. Figure 5 shows the relationship between the track and lock thresholds. Note that the track upper and lower thresholds for weight class two (2) are closer together than the lock upper and lower thresholds for weight class two (2). Thus, the upper threshold for weight class (2) is increased and the lower threshold is decreased when class (2) is the locked class.

Figure 6 is a flow chart showing the process for determining the current weight class sample. When the process is started, there is a determination of whether the process is in the track or lock mode. If the process is in the track mode than the current estimated weight is compared to the previous class' track lower threshold. If the current estimated weight is less than the previous class' track lower threshold than the next lower weight class is set as the current weight class. If the current estimated weight is not less than the previous class' track lower threshold than the estimated weight is compared to the previous class' track upper threshold. If the current estimated weight is greater than the previous class' track upper threshold than the next higher weight class is set as the current weight class. If the current estimated weight is not greater than the previous class' track upper threshold than the current weight class is the same as the previous weight class. A similar method is used when the process is in the lock mode except the current estimated weight is compared to the previous class' lock upper and lower thresholds.

As the process moves through each iteration, a history of the comparisons between the estimated weight and the weight class thresholds is observed and recorded, see Figure 7. The weight class samples are monitored, looking for the same class sample to be repeated. The process starts counting or tracks consecutive samples of the

same weight class. If a non-consistent sample is observed, the count is reset to zero. When a predetermined number of consistent and consecutive samples is observed, that observed weight class becomes locked. Once a class is locked, it remains the designated occupant weight class until a specific number of consecutive weight class samples above or below the locked class is observed. If the lock is lost, the process starts tracking the number of consecutive weight classes again and the process is repeated. The output is either the tracked or locked weight class, depending on the mode. If a class is locked, the locked class is the output class. If a class is not locked, the track weight class is the output class. The track/lock feature helps to filter out class changes caused by occupants 20 that change position, class changes caused by adverse road conditions, and class changes resulting from sudden vehicle maneuvers such as turning or braking.

Given this description, those skilled in the art will be able to choose from among commercially available microprocessors to realize the functions of the controller weight classification modules 30 and 32. Similarly, those who have the benefit of this description will be able to design custom circuitry or software to accomplish the method of this invention.

This invention provides the advantage of customizing transition rates between weight classifications and enhances the intelligence of a decision making process in that regard.

The preceding description is exemplary rather than limiting in nature. Variations and modifications to the disclosed embodiments may become apparent to those skilled in the art that do not necessarily depart from the purview and spirit of this invention. The scope of legal protection for this invention can only be determined by studying the following claims.

CLAIMS

We claim:

1. A method of determining a classification of determined weight information, comprising the steps of:

(A) defining a plurality of classification zones;

(B) determining when the weight information is within one of the zones;

(C) increasing a value for the zone in which the weight information is when the weight information is in said zone;

(D) determining which of the zones has the highest value; and

(E) classifying the weight information into the classification zone having the highest value.

2. The method of claim 1, wherein step (B) includes monitoring the weight information over time and determining a representation of the weight information over time.

3. The method of claim 2, including integrating a value of the representation of the weight information within each of the zones and using the integrated value when performing step (D).

4. The method of claim 1, wherein step (C) includes determining a summation of a representation of the weight information over time within the zone in which the weight information is and using the summation as the value of the zone.

5. The method of claim 1, including performing step (C) for the zone in which the weight information is only until a maximum value for the zone is reached.

6. The method of claim 1, wherein step (A) includes having portions of adjacent zones overlap such that the weight information can be within two zones simultaneously.

7. The method of claim 6, including simultaneously performing steps (B) and (C) for each of two adjacent zones when the weight information is within each of the adjacent zones.

8. The method of claim 1, including decreasing a value for each of the other zones when the weight information is not in the other zones.

9. The method of claim 8, wherein the step of decreasing a value is performed for the other zones, respectively, only until a minimum value for the other zones is reached, respectively.

10. A method of classifying determined weight information, comprising the steps of:

(A) defining a plurality of classification zones that each has an upper limit and a lower limit;

(B) setting the upper limit of one of the zones to be above a lower limit of an adjacent zone;

(C) determining a value for each zone that is indicative of an amount that the weight information is within each zone; and

(D) classifying the weight information within the zone with the greatest value.

11. The method of claim 10, wherein there is a first zone and a last zone and including setting the upper limit of all of the zones excluding the last zone to be above a lower limit of an adjacent zone and setting the lower limit of all of the zones excluding the first zone to be below the upper limit of an adjacent zone.

12. The method of claim 10, wherein step (C) includes increasing a value for the zone in which the weight information is when the weight information is in said zone.

13. The method of claim 12, including simultaneously performing step (C) for each of two adjacent zones when the weight information is within each of the adjacent zones.

14. The method of claim 12, including decreasing a value for each of the other zones when the weight information is not in the other zones.

15. The method of claim 10, wherein step (C) includes determining a summation of a representation of the weight information over time within the zone in which the weight information is and using the summation as the value of the zone.

16. A system for classifying weight information within one of a plurality of classes in a vehicle weight classification assembly, comprising:

a controller that determines when the weight information is within at least one of a plurality of zones associated with the classes, increases a value for a zone when the weight information is within said zone, determines which of the zones has the highest value and classifies the weight information into the class associated with the zone having the highest value.

17. The system of claim 16, wherein the controller increases a value of a zone containing the weight information and decreases a value of any zone that does not contain the weight information.

18. The system of claim 16, wherein the controller determines a summation of a representation of the weight information within each zone and uses the summation as the value of the zone to make the classification determination.

19. A method for classifying a seat occupant into a weight class comprising the steps of:

(a) measuring the weight of a seat occupant to generate an estimated weight;

(b) comparing the estimated weight to a series of weight classes each having at least one weight class threshold to determine an individual classification sample;

(c) repeating steps (a) and (b) until a predetermined number of individual classification samples having the same value is achieved; and

(d) locking the individual classification sample as the occupant weight class.

20. The method according to claim 19, including the steps of generating an occupant weight class signal after step (d), transmitting the occupant weight class signal to a control unit, and modifying deployment of an airbag based on the occupant weight class signal.

21. The method according to claim 20, including the steps of:

(e) unlocking the individual classification sample when a predetermined number of non-equal individual classification samples is achieved; and

(f) returning to step (a) when step (e) is satisfied.

22. The method according to claim 21, wherein step (b) further includes assigning each weight class an upper threshold and a lower threshold, comparing the estimated weight to the upper and lower thresholds for the last known weight class, and setting the individual classification sample equal to the last known weight class if the estimated weight is between the upper and lower thresholds for the last known weight class.

23. The method according to claim 22, including the step of setting the individual classification sample equal to a next higher weight class if the estimated weight is greater than the upper threshold for the last known weight class or setting the individual classification sample equal to a next lower weight class if the estimated weight is less than the lower threshold for the last known weight class.

24. The method according to claim 23, including the steps of increasing the value of the upper threshold of the individual classification sample by a first predetermined amount and decreasing the value of the lower threshold of the individual classification sample by a second predetermined amount once the individual classification sample is locked.

25. The method according to claim 23, including the steps of decreasing the value of the upper threshold of the individual classification sample by a first predetermined amount and increasing the value of the lower threshold of the individual classification sample by a second predetermined amount after the individual classification sample is unlocked.

26. An occupant weight classification system comprising;

a sensor assembly for measuring the weight of a seat occupant to generate an estimated weight signal;

a series of weight class data wherein each weight class has an upper threshold and a lower threshold;

a control unit for receiving said estimated weight signal, comparing said signal to said upper and lower thresholds to assign said signal an appropriate weight class designation, and for locking said signal into an occupant specific weight class when a predetermined number of consistent and consecutive weight class designations is achieved.

27. A system according to claim 26, including an airbag controller for controlling deployment of an airbag wherein said control unit generates a control signal and transmits said control signal to said airbag controller to modify deployment of said airbag based on said occupant specific weight class.

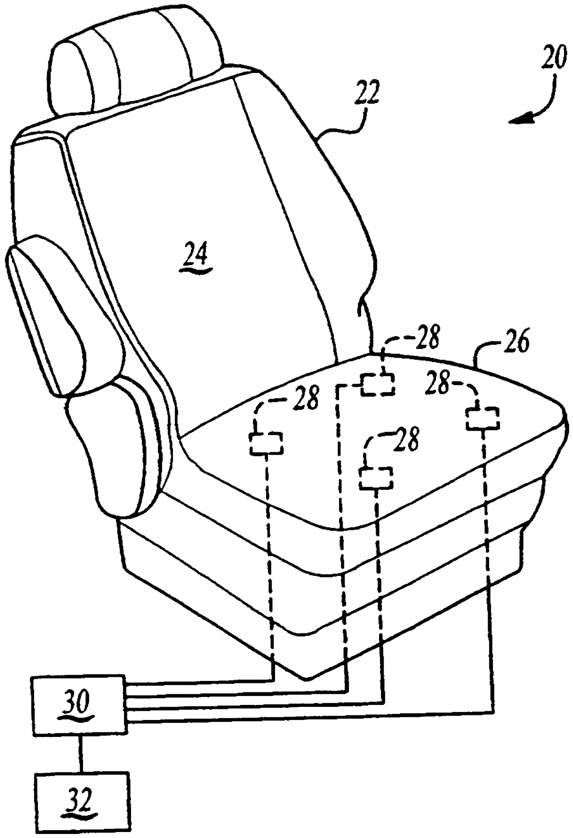


Fig-1

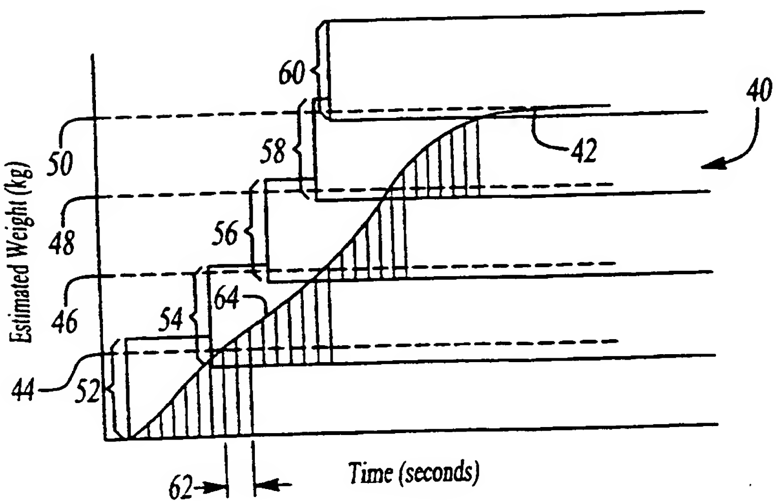


Fig-2

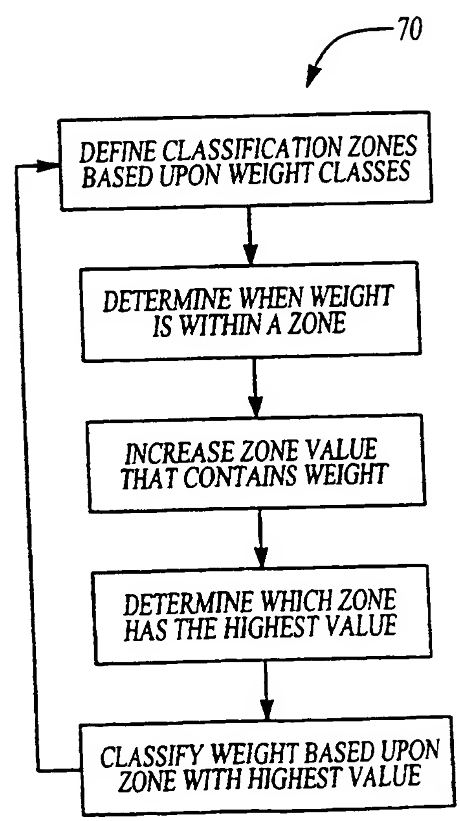


Fig-3

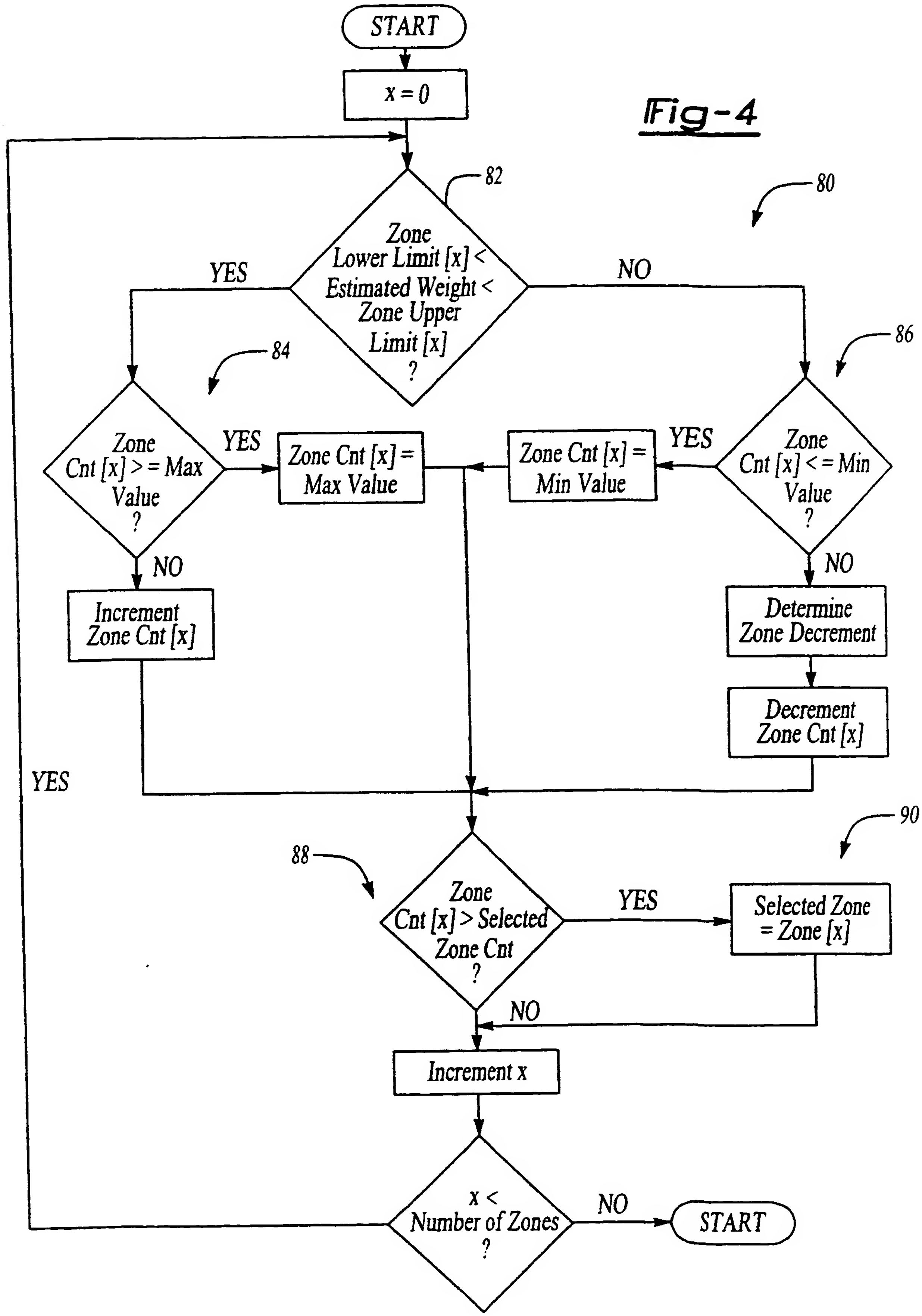

START
x = 0
Zone Lower Limit [x] < Estimated Weight < Zone Upper Limit [x] ?
82
80
YES
NO
84
86
Zone Cnt [x] > = Max Value ?
YES
Zone Cnt [x] = Max Value
Zone Cnt [x] = Min Value
YES
Zone Cnt [x] < = Min Value ?
NO
NO
Increment Zone Cnt [x]
Determine Zone Decrement
Decrement Zone Cnt [x]
YES
90
88
Zone Cnt [x] > Selected Zone Cnt ?
YES
Selected Zone = Zone [x]
NO
Increment x
x < Number of Zones ?
NO
START

Fig-4

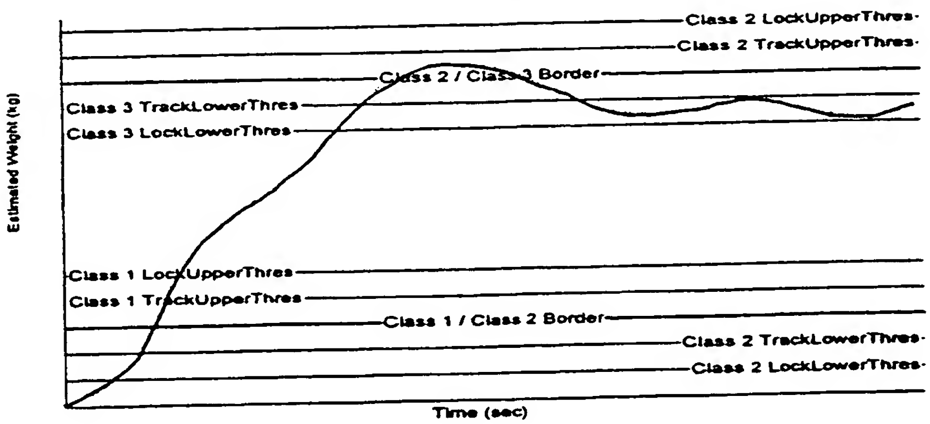

Class 2 LockUpperThres
Class 2 TrackUpperThres
Class 2 / Class 3 Border
Class 3 TrackLowerThres
Class 3 LockLowerThres
Estimated Weight (kg)
Class 1 LockUpperThres
Class 1 TrackUpperThres
Class 1 / Class 2 Border
Class 2 TrackLowerThres
Class 2 LockLowerThres
Time (sec)

Fig 5

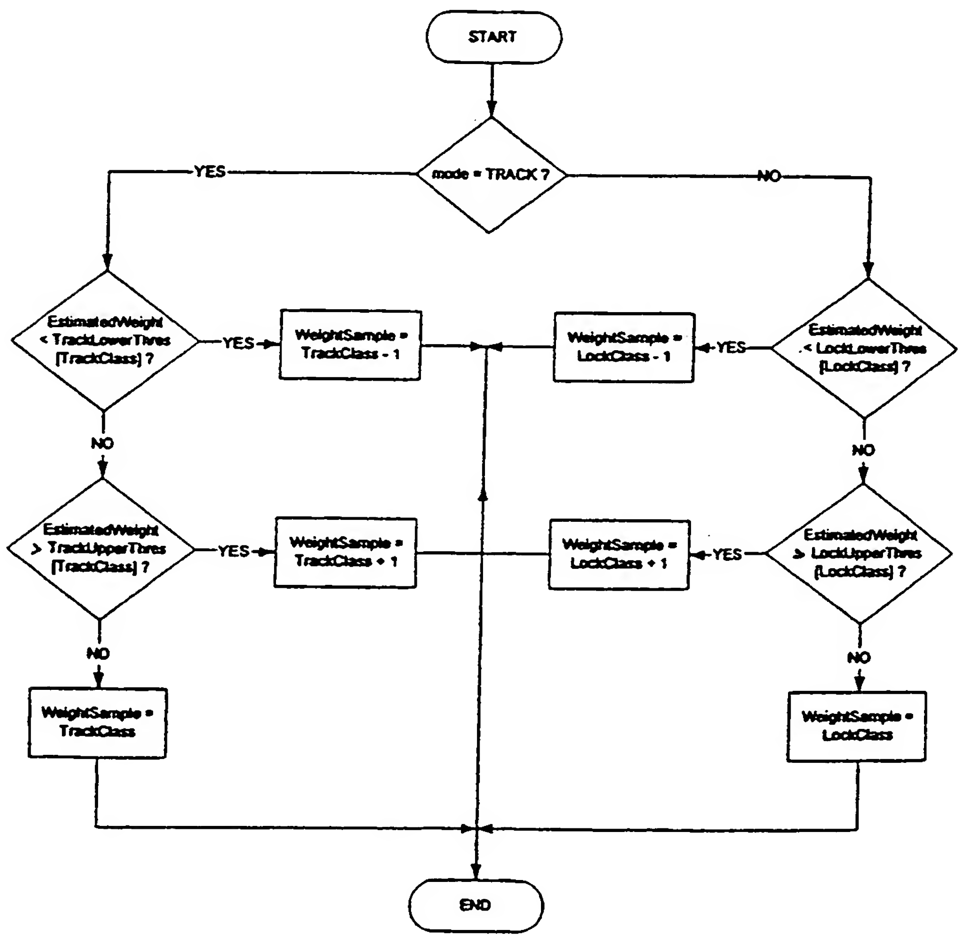

START
mode = TRACK ?
YES
NO
EstimatedWeight < TrackLowerThres [TrackClass] ?
WeightSample = TrackClass - 1
WeightSample = LockClass - 1
EstimatedWeight < LockLowerThres [LockClass] ?
EstimatedWeight > TrackUpperThres [TrackClass] ?
WeightSample = TrackClass + 1
WeightSample = LockClass + 1
EstimatedWeight > LockUpperThres [LockClass] ?
WeightSample = TrackClass
WeightSample = LockClass
END

Fig. 6

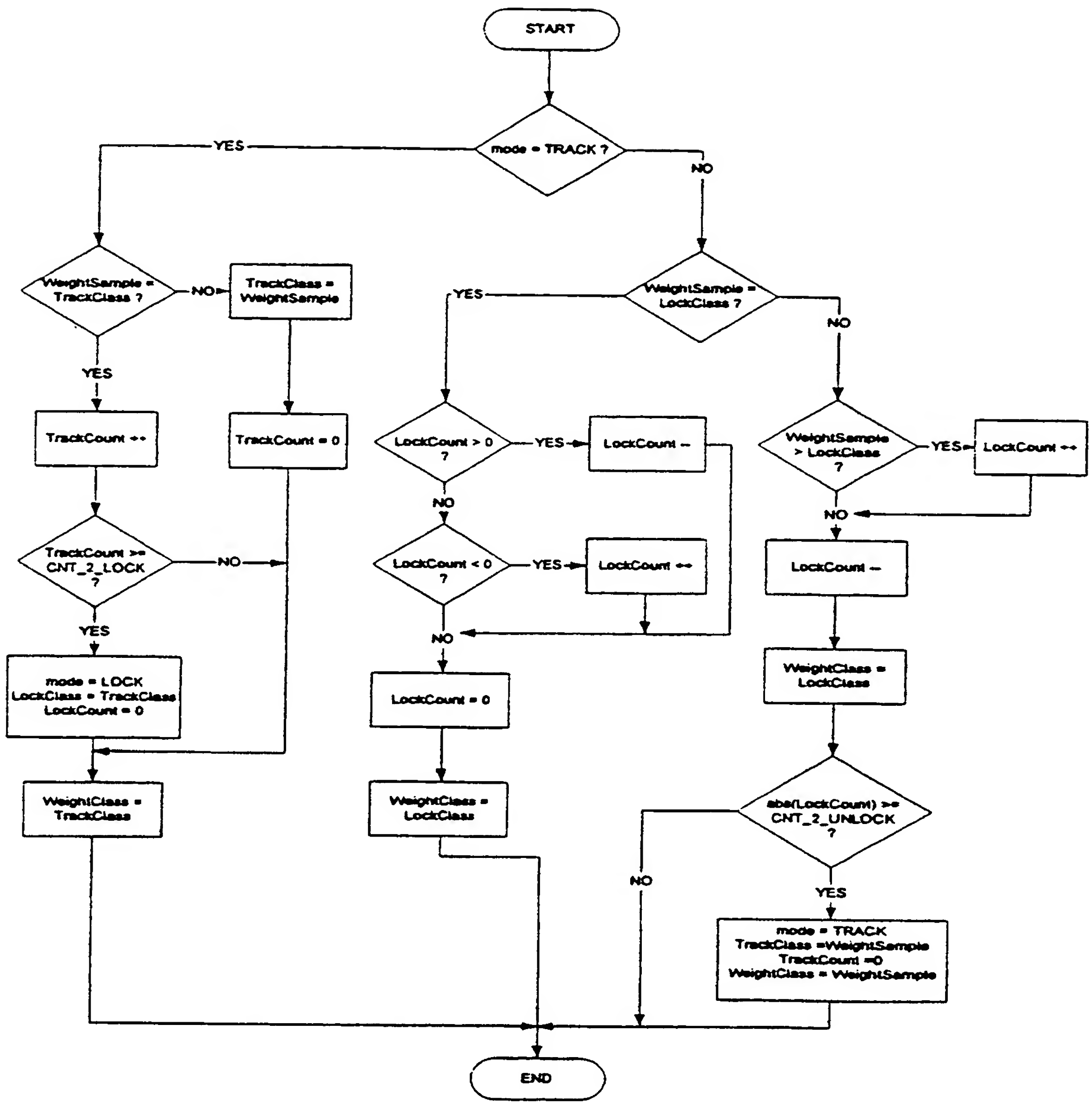

START
mode = TRACK ?
YES
NO
WeightSample = TrackClass ?
TrackClass = WeightSample
TrackCount ++
TrackCount = 0
TrackCount >= CNT_2_LOCK ?
mode = LOCK
LockClass = TrackClass
LockCount = 0
WeightClass = TrackClass
WeightSample = LockClass ?
LockCount > 0 ?
LockCount --
LockCount < 0 ?
LockCount ++
LockCount = 0
WeightClass = LockClass
WeightSample > LockClass ?
LockCount ++
LockCount --
WeightClass = LockClass
abs(LockCount) >= CNT_2_UNLOCK ?
mode = TRACK
TrackClass =WeightSample
TrackCount =0
WeightClass = WeightSample
END

Fig. 7

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 00/23681

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G01G19/414

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G01G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 97 10115 A (SCHOOS ALOYSE ;SERBAN BOGDAN (LU); IEE SARL (LU)) 20 March 1997 (1997-03-20) page 2, line 28 -page 3, line 2 page 5, line 8 -page 6, line 9 page 8, line 5 - line 11 ---	1,10,16, 19,26
X	WO 98 14345 A (SCHOOS ALOYSE ;SERBAN BODGAN (LU); IEE SARL (LU); WITTE MICHEL (LU) 9 April 1998 (1998-04-09) page 2, line 29 -page 3, line 1 page 4, line 12 - line 21 page 15, line 5 - line 11 page 16, line 4 - line 14; figure 1 --- -/--	1,10,16, 19,26

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
8 December 2000	18/12/2000

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Ganci, P

1

INTERNATIONAL SEARCH REPORT

International Application No
PCT/US 00/23681

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 99 24285 A (SIEMENS AUTOMOTIVE CORP LP) 20 May 1999 (1999-05-20) page 3, line 11 - line 14 page 11, line 3 - line 15	1,10,16, 19,26
P,X	US 6 070 115 A (LICHTINGER HAROLD ET AL) 30 May 2000 (2000-05-30) cited in the application column 2, line 17 - line 21 column 6, line 31 - line 46 column 5, line 47 - line 50 claims 3,4,6,7	1,10,16, 19,26
X	WO 99 38731 A (THEISS EDGARD ;BILLEN KARL (DE); IEE SARL (LU); FEDERSPIEL LAURENT) 5 August 1999 (1999-08-05) column 3, line 7 - line 21	1,10,16, 19,26

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No
PCT/US 00/23681

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 9710115 A	20-03-1997	LU 88655 A	12-03-1997
		AT 180220 T	15-06-1999
		DE 69602539 D	24-06-1999
		DE 69602539 T	13-04-2000
		EP 0850154 A	01-07-1998
		ES 2131406 T	16-07-1999
WO 9814345 A	09-04-1998	LU 88823 A	03-04-1998
		LU 90042 A	22-09-1998
		AU 4704597 A	24-04-1998
		EP 0929410 A	21-07-1999
WO 9924285 A	20-05-1999	AU 1402599 A	31-05-1999
		EP 1028867 A	23-08-2000
		US 6070115 A	30-05-2000
US 6070115 A	30-05-2000	AU 1402599 A	31-05-1999
		EP 1028867 A	23-08-2000
		WO 9924285 A	20-05-1999
WO 9938731 A	05-08-1999	LU 90202 A	29-07-1999
		EP 1051311 A	15-11-2000